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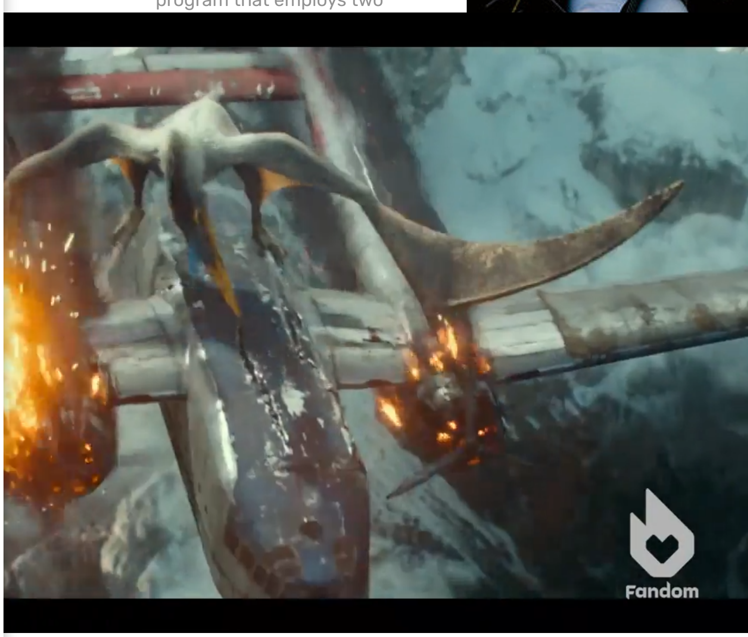
Voyager program

This article is about the space probes launched in 1977. For other uses, see Voyager.

The **Voyager program** is a continuing American scientific program that employs two

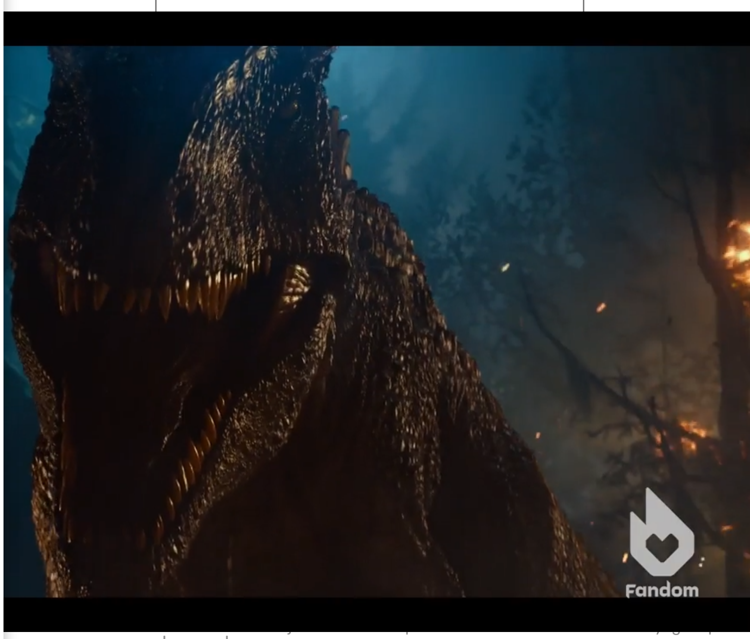


On August 25, 2012, data from Voyager 1 indicated that it had become the first human-made object to enter interstellar space, traveling "further than anyone, or anything, in history".[1] As of 2013, Voyager 1 was moving with a velocity of 17 kilometers per second (Template:Convert/round mi/s) relative to the Sun.[2] Voyager 2 is expected to enter interstellar space by 2016, and its plasma spectrometer should provide the first direct measurements of the density and temperature of the interstellar plasma.[3]

details about each of the giant planets and their moons. Close-up images from the spacecraft charted Jupiter's complex cloud forms, winds, and storm systems and discovered volcanic activity on its moon Io. Saturn's rings were found to have enigmatic braids, kinks, and spokes and to be accompanied by a myriad of "ringlets." At Uranus Voyager 2 discovered a substantial magnetic field around the planet and 10 additional moons. Its flyby of Neptune uncovered three complete rings and six hitherto unknown moons as well as a planetary magnetic field and complex, widely distributed auroras. Voyager 2 is still the only spacecraft to have visite

The Voyager spacecraft were built at the Jet Propulsion Laboratory in Southern California, and they were paid for by the National Aeronautics and Space Administration (NASA), which also paid for their launchings from Cape Canaveral, Florida, their tracking, and everything else concerning the space probes.

Contents



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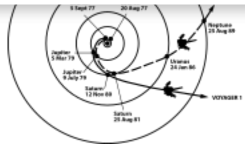
Mariner program, and they were thus initially named Mariner 11 and Mariner 12. They were then moved into a separate program named *Mariner Jupiter-Saturn*, later renamed the *Voyager Program* because it was thought that the design of the two space probes had progressed sufficiently beyond that of the Mariner family to merit a separate name.[4]

The Voyager Program was similar to the Planetary Grand Tour planned during the late 1960s and early 70s. The Grand Tour would take advanta

engineer at the Jet Propulsion Laboratory. This alignment, which occurs once every 175 years,[5] would occur in the late 1970s and make it possible to use gravitational assists to explore Jupiter, Saturn, Uranus, Neptune, and Pluto. The Planetary Grand Tour was to send several pairs of probes to fly by all the outer planets (including Pluto, then still considered a planet) along vario

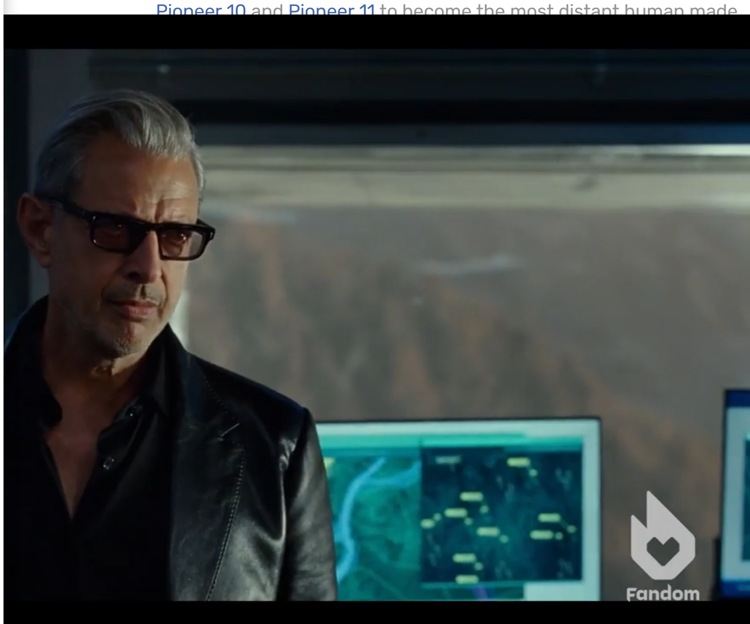


The trajectories that enabled Voyager spacecraft to visit the outer planets and achieve velocity to escape the Solar System

Neptune. Limited funding ended the Grand Tour program, but elements were incorporated into the *Voyager* Program, which fulfilled many of the flyby objectives of the Grand Tour except a visit to Pluto.

Voyager 2 was the first to launch. Its trajectory was designed to allow flybys of Jupiter, Saturn, Uranus, and Neptune. Voyager 1 was launched after Voyager 2, but along a shorter and faster trajectory that was designed to provide an optimal flyby of Saturn's moon Titan,[6] which was known to be quite large and to possess a dense atmosphere. This encounter sent Voyager 1 out of the plane of the ecliptic, ending its planetary science mission.[7] Had *Voyager 1* been unable to perform the Titan flyby, the trajectory of Voyager 2 could have been altered to explore Titan, forgoing any visit to Uranus and Neptune.[8] Voyager 1 was not launched on a trajectory that would have allowed it to continue to Uranus and Neptune, but could have continued from Saturn to Pluto without exploring Titan.[9]

During the 1990s, Voyager 1 overtook the slower deep-space probes Pioneer 10 and Pioneer 11 to become the most distant human made



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when the magnetic field of the Sun becomes warped at the edge of the Solar System.[12]

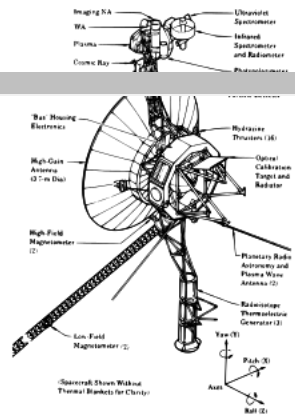
On 15 June 2012, scientists at NASA reported that Voyager 1 was very close to entering interstellar space, indicated by a sharp rise in high-energy particles from outside the Solar System.[13][14] In September 2013, NASA announced that Voyager 1 had crossed the heliopause on August 25, 2012, making it the first spacecraft to enter interstellar space.[15][16][17]

expected to be able to operate science instruments through 2020, when limited power will require instruments to be deactivated one by one. Sometime around 2025, there will no longer be sufficient power to operate any science instruments.

Spacecraft design

The Voyager spacecraft weigh 773 kilograms. Of this, 105 kilograms are scier

identical Voyager spacecraft use three-axis-stabilized guidance systems that use gyroscopic and accelerometer inputs to their attitude control computers to point their high-gain antennas towards the Earth and their scientific instruments towards their targets, sometimes with the help of a movable instrument platform for the smaller instruments and the electronic photography system.



Voyager spacecraft structure

The diagram at the right shows the high-gain antenna (HGA) with a 3.7 m diameter dish attached to the hollow decagonal electronics container. There is also a spherical tank that contains the hydrazine monopropellant fuel.

The Voyager Golden Record is attached to one of the bus sides. The

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Subsystem (PWS) data. The data is played back every six months.

The Imaging Science Subsystem, made up of a wide angle and a narrow angle camera, is a modified version of the slow scan vidicon camera designs that were used in the earlier Mariner flights. The Imaging Science Subsystem consists of two television-type cameras, each with eight filters in a commandable Filter Wheel mounted in front of the vidicons. One has a low resolution 200 mm focal length wide-angle lens with an aperture of f/3 (the wide angle camera), while the other uses a higher resolution 1500 mm narrow-angle f/8.5 lens (the narrow angle camera).


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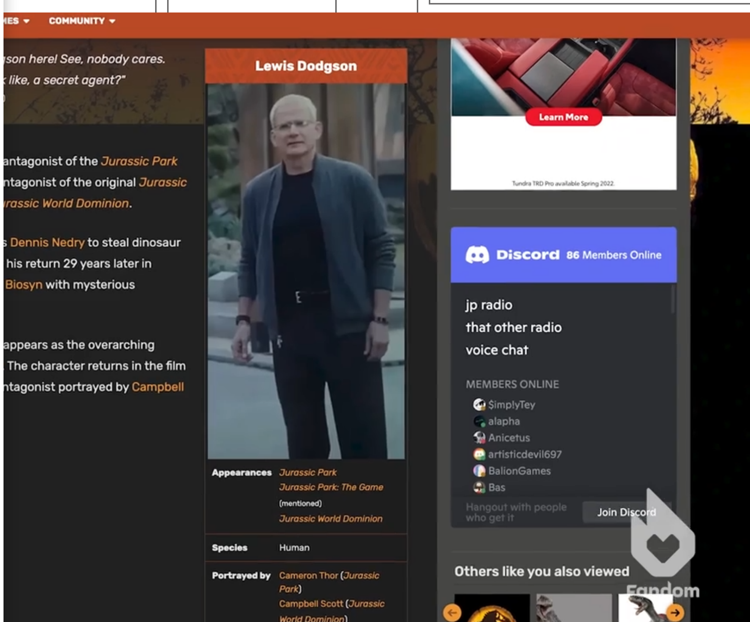
Instrument Name	Abr.	De
Imaging Science System	(**ISS**)	Utilized a two-camera system (narrow-angle and other objects along the trajectory. **More** y.do?id=1977-084A-01)

Narrow Angle Camera Filters[20]

Name	Wavelength	Spectrum	Sensitivi
Clear	280–640 nm		
UV	280–370 nm		
Violet	350–450 nm		
Blue	430–530 nm		
Green	530–640 nm		
Orange	590–640 nm		



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Instrument Name	Abr.	De
Infrared Interferometer Spectrometer	(**IRIS**)	• **Principal investigator:** Rudolf Hanel / NASA (gs.seti.org/voyager/iris/instrument.html)) • **Data:** PDS/PRN data catalog (http://pds-rings. expanded data catalog (http://pds-rings.seti.o p://pds-rings.seti.org/vol/VGIRIS_0001_peer_ 002_peer_review/)), NSSDC Jupiter data arch oyager1/infrared_interferometer_spectromet
Ultraviolet	(**UVS**)	Designed to measure atmospheric prope

		seti.org/voyager/uvs/instrument.html)) • **Data:** PDS/PRN data catalog (http://pds-rings.
Triaxial Fluxgate Magnetometer	**(MAG)**	Designed to investigate the magnetic fields c the magnetospheres of these planets, and th boundary with the interstellar magnetic field a.gov/nmc/experimentDisplay.do?id=1977-08 • **Principal investigator:** Norman Ness / NASA a.gov/)) _1_Magnetometer_Investigation), NSSDC data ger/voyager1/magnetic_fields/)
Plasma Spectrometer	**(PLS)**	Investigated the macroscopic properties of t energy range from 5 eV to 1 keV. **More** (http:/ =1977-084A-06) • **Principal investigator:** John Richardson / MI ml)) • **Data:** PDS/PPI data catalog (http://ppi.pds.nas _1_Plasma_Science_Investigation), NSSDC d yager/voyager1/plasma/)
Low Energy Charged Particle Instrument	**(LECP)**	Measures the differential in energy fluxes an differential in energy ion composition. **More** (do?id=1977-084A-07) • **Principal investigator:** Stamatios Krimigis / J www.jhuapl.edu/VOYAGER/) / UMD website (h cs.com/default.htm)) -mac.u =Voya gsfc.n
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		er to v/nm / Univ ds.nas vestig ecraft_data/voyager/voyager1/planet_radio_
Photopolarimeter System	**(PPS)**	Utilized a 6-inch f/1.4 Dahl-Kirkham-type Ca containing five analyzers of 0,60,120,45 and bands covering 2350 to 7500A to gather info Jupiter, Saturn, Uranus and Neptune and inf density for these planets. **More** (http://nssdc 084A-11) • **Principal investigator:** Charles F. Lillie/LASP JPL (PDS/PRN website (http://pds-rings.s

Plasma Wave System	(**PWS**)	Provides continuous, sheath-independent m Jupiter and Saturn as well as basic informati studying the magnetospheres. **More** (http:// 1977-084A-13) • **Principal investigator:** Donald Gurnett / Univ ma-wave/voyager/)) • **Data:** PDS/PPI data catalog (http://ppi.pds.nas

Computers and data processing

There are three different computer types on the Voyager spacecraft, two of each kind, sometimes used for redundancy. They are proprietary, custom-built computers built from CMOS and TTL medium scale integrated circuits and discrete components. Total number of words among the six computers is about 32K. Voyager 1 and Voyager 2 have identical computer systems.[22][23]

The Computer Command System (CCS), the central controller of the spacecraft, is two 18-bit word, interrupt type processors with 4096 words each of plated wire, non-volatile memory. During most of the Voyager mission the two CCS computers on each spacecraft were used non-redundantly to increase the command and processing capability of the spacecraft. The CCS is nearly identical to the system flown on the Viking spacecraft.[24]

The Flight Data System (FDS) is two 16-bit word machines with modular memories and 8198 words each

The Attitude and Articulation Control Subsystem (AACS) controls the spacecraft orientation (its attitude). It keeps the high-gain antenna pointing towards the Earth, controls attitude changes, and points the scan platform. The custom-built AACS systems on both craft are identical.

It has been erroneously reported [26] on the Internet that the Voyager space probes were controlled by a version of the RCA 1802 (RCA CDP1802 "COSMAC" microprocessor), but such claims are not supported by the primary design documents. The CDP1802 microprocessor was

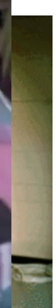
microprocessor integrated circuit chip.

Communications

The uplink communications are executed via S-band microwave communications. The downlink communications are carried out by an X-band microwave transmitter on board the spacecraft, with an S-band transmitter as a back-up. All long-range communications to and from the two Voyagers have been carried out using their 3.7-meter high-gain antennas.

Because of the inverse-square law in radio communications, the digital data rates used in the downlinks from the Voyagers have been continually decreasing the farther that they get from the Earth. For example, the data rate used from Jupiter was about 115,000 bits per second. That was halved at the distance of Saturn, and it has gone down continually since then.[27] Some measures were taken on the ground along the way to reduce the effects of the inverse-square law. In between 1982 and 1985, the diameters of the three main parabolic dish antennas of the Deep Space Network was increased from 64 m to 70 m, dramatically increasing their areas for gathering weak microwave signals.

Then between 1986 and 1989, new techniques were brought into play to combine the signals from multiple antennas on the ground into one, more powerful signal, in a kind of an antenna array. This was done at Goldstone, California, Canberra, and Madrid using the additional dish antennas available there. Also, in Australia, the Parkes Radio Telescope was brought into the array in time for the fly-by of Neptune in 1989. In the United States, the Very Large Array in New Mexico was brought into temporary



initial power. Additionally, the thermocouples that convert heat into electricity also degrade, reducing available power below this calculated level.

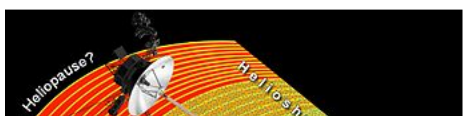
By 7 October 2011 the power generated by Voyager 1 and Voyager 2 had dropped to 267.9 W and 269.2 W respectively, about 57% of the power at launch. The level of power output was better than pre-launch predictions based on a conservative thermocouple degradation model. As the electrical power decreases, spacecraft loads must be turned off, eliminating some capabilities.

The Voyager primary mission was completed in 1989, with the close flyby of Neptune by *Voyager 2*. The Voyager Interstellar Mission (VIM) is a mission extension, which began when the two spacecraft had already been in flight for over 12 years.[29] The Heliophysics Division of the NASA Science Mission Directorate conducted a Heliophysics Senior Review in 2008. The panel found that the VIM "is a mission that is absolutely imperative to continue" and that VIM "funding near the optimal level and increased DSN (Deep Space Network) support is warranted."[30]

The r

System beyond the outer planets to the outer limit and if possible even beyond. The Voyagers continue to search for the heliopause boundary which is the outer limit of the Sun's magnetic field. Passing through the heliopause boundary will allow the spacecraft to make measurements of the interstellar fields, particles and waves unaffected by the solar wind.

As of the present date, the Voyager 2 and Voyager 1 scan platforms, including all of the platform instruments, have been powered down. The ultraviolet spectrometer (UVS)[31] on Voyager 1 was active until 2003, when it too was deactivated. Gyro operations will end in 2016 for Voyager 2 and 2017 for Voyager 1. Gyro operations are used to rotate the probe 360 degrees six times per year to measure the magnetic field of the spacecraft, which is then subtracted from the magnetometer science data.



The two spacecraft continue to

support science instrument operation. At that time, science data return and spacecraft operations will cease.[33]

Humanity's Farthest Journey

Mission Details

By the start of VIM, Voyager 1 was at a distance of 40 AU from the Earth while Voyager 2 was at 31 AU.[34] VIM is broken down into 3 distinct phases: termination shock, heliosheath exploration, interstellar

dominated by those contained in the expanding supersonic solar wind. This is the characteristic environment of the termination shock phase. At some distance from the Sun, the supersonic solar wind will be held back from further expansion by the interstellar wind. The first feature encountered by a spacecraft as a result of this interstellar wind/solar wind interaction was the termination shock where the solar wind slows from supersonic to subsonic speed and large changes in plasma flow direction and magnetic field orientation occur.

Voya

at a distance of 94 AU while Voyager 2 completed it in August 2007 at a distance of 84 AU. After entering into the heliosheath the 2 spacecraft are in an area that is dominated by the Sun's magnetic field and solar wind particles. The thickness of the heliosheath is not know clearly so the time required to transverse this space is not quite clear. Scientists estimate this space to be tens of AU thick and that it could take several years to cross. After passing through the heliosheath the 2 Voyagers will begin the phase of interstellar exploration. The outer boundary of the heliosheath is called the heliopause which is where the 2 spacecraft are headed now. This is the region where the Sun's influence begins to decrease and the interstellar space can be detected. The heliopause has never been reached by any spacecraft so far and the Voyagers maybe the first spacecraft to reach it. Currently Voyager 1 is escaping the solar system at the speed of 3.6 AU per year while Voyager 2 speed is about 3.3 AU per year. The Voyager spacecraft will eventually go on to the stars. In about 40,000 years Voyager 1 will be within 1.6 light years of AC+79 3888 which is a star in the constellation of Camelopardalis. In 40,000 years Voyager 2 will be within 1.7 light years from star Ross 248 and will go to pass within 4.6 light years from Sirius (which is the brightest star in the

Voyager telemetry operates at these transmission rates:

- 7200, 1400 bit/s tape recorder playbacks
- 600 bit/s real-time fields, particles, and waves; full UVS; engineering
- 160 bit/s real-time fields, particles, and waves; UVS subset; engineering
- 40 bit/s real-time engineering data, no science data.

Note: At 160 and 600 bit/s different data types are interleaved.

The Voyager craft have three different telemetry formats:

- CR-5T (ISA 35395) Science [1] (http://voyager.jpl.nasa.gov/mission/weekly-reports/2010-05-07.html), note that this can contain some engineering data.
- FD-12 higher accuracy (and time resolution) Engineering data, note that some science data may also be encoded.

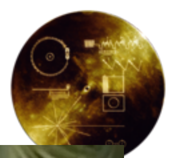
Low rate

- EL-40 Engineering [2] (http://voyager.jpl.nasa.gov/mission/weekly-reports/2010_05_14.html), note that this format can contain some science data, but not all systems represented.
- This is an abbreviated format, with data truncation for some subsystems.

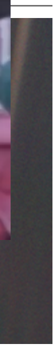
It is understood that there is substantial overlap of EL-40 and CR-5T (ISA 35395) telemetry, but the simpler EL-40 data does not have the resolution of the CR-5T telemetry. At least when it comes to representing available electricity to subsystems, EL-40 only transmits in integer increments—so similar behaviors are expected elsewhere.

Memory dumps are available in both engineering formats. These routine diagnostic procedures have detected and corrected intermittent memory bit flip problems, as well as detecting the permanent bit flip problem that caused a two-week data loss event mid-2010.

Voyager Golden Record



Main article: Voyager Golden Record



media outlets. Among the best-known of these is an image of the Earth as a pale blue dot, taken in 1990 by Voyager 1, and popularized by Carl Sagan with the quote:

Seen from 6 billion kilometers (3.7 billion miles), Earth appears as a "pale blue dot" (the blueish-white speck approximately halfway down the brown band to the right).

> "Consider again that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who

suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor

morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there – on a mote of dust suspended in a sunbeam".

In popular culture

- The *Space: 1999* episode *Voyager's Return* featured two fictional 1985 space probes, called Voyager One and Voyager Two (not "1" and "2"). This episode was aired two years prior to the launch of the real Voyager craft. The plot hinges upon the dangerous radioactive engines of the probes, which bears a

File:Space 1999 - Voyager's Return screencap.jpg

Voyager One, from *Space: 1999*.

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External links

mary/Descanso4--Voyager_new.pdf)

NASA instrument information pages:

- "Voyager instrument overview:" (http://starbrite.jpl.nasa.gov/pds/viewHostProfile.jsp?INSTRUMENT_HOST_ID=VG2). http://starbrite.jpl.nasa.gov/pds/viewHostProfile.jsp?INSTRUMENT_HOST_ID=VG2.
- "CRS – COSMIC RAY SUBSYSTEM" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=CRS&INSTRUMENT_

INSTRUMENT_ID=CRS&INSTRUMENT_HOST_ID=VG1.

- "ISS NA – IMAGING SCIENCE SUBSYSTEM – NARROW ANGLE" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=ISSN&INSTRUMENT_HOST_ID=VG2). http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=ISSN&INSTRUMENT_HOST_ID=VG2.
- "ISS WA – IMAGING SCIENCE SUBSYSTEM – WIDE ANGLE" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=ISSW&INSTRUMENT_HOST_ID=VG2). INSTRUMENT_ID=ISSW&INSTRUMENT_HOST_ID=VG2.
- "IRIS – INFRARED INTERFEROMETER SPECTROMETER AND RADIOMETER" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=IRIS&INSTRUMENT_HOST_ID=VG2). http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=IRIS&INSTRUMENT_HOST_ID=VG2.
- "LECP – LOW ENERGY CHARGED PARTICLE" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=LECP&INSTRUMENT_HOST_ID=VG2). http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=LECP&INSTRUMENT_HOST_ID=VG2.
- "MAG – TRIAXIAL FLUXGATE MAGNETOMETER" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=MAG&INSTRUMENT_HOST_ID=VG2). http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=MAG&INSTRUMENT_HOST_ID=VG2.
- "PLS – PLASMA SCIENCE EXPERIMENT" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=PLS&INSTRUMENT_HOST_ID=VG2).

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MENT_HOST_ID=VG1). http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=RSS-VG1S&INSTRUMENT_HOST_ID=VG1.

- "UVS – ULTRAVIOLET SPECTROMETER" (http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=UVS&INSTRUMENT_HOST_ID=VG1). http://starbrite.jpl.nasa.gov/pds/viewInstrumentProfile.jsp?INSTRUMENT_ID=UVS&INSTRUMENT_HOST_ID=VG1.

Non-NASA sites

- NPR: Science Friday 8/24/07 Interviews for 30th anniversary of Voyager spacecraft (http://www.sciencefriday.com/pages/2007/Aug/hour1_082407.html)
- Illustrated technical paper (http://www.stickings90.webspace.virginmedia.com/voyager.htm) by RL Heacock, the project engineer
- Gray, Meghan. "Voyager and Interstellar Space" (http://www.deepskyvideos.com/videos/other/voyager.html). *Deep Space Videos*. Brady Haran. http://www.deepskyvideos.com/videos/other/voyager.html.

Probes	*Voyager 1* • *Voyager 2*
Concepts	Gravity assist • Radioisotope thermoelectric generator • Specific orbital energy of *Voyager 1*
Work	*Pale Blue Dot* • *Family Portrait* • Voyager Golden Record (Contents)
Voyager team	Stamatios Krimigis • Carolyn Porco • Raymond Heacock • Jim Blinn • Edward C. Stone • Timothy Ferris
Observations	Enceladus • Masubi (volcano) • Exploration of Jupiter • Exploration of Saturn • Exploration of Uranus • Prometheus (volcano) • Exploration of Io • Rings of Neptune • Dunyazad (crater) • Surt (volcano) • Shahrazad

• Johnson Space Center (Mission Control • Lunar Sample Laboratory)

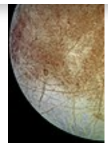
Robotic programs	**Past**	Hitchhiker • Mariner • Mariner Mark II • MESUR • Mars Surveyor '98 • New Millennium • Lunar Orbiter • Pioneer • Planetary Observer • Ranger • Surveyor • Viking • Project Prometheus • Mars Scout
	Current	Living With a Star • Lunar Precursor Robotic Program •

		Small explorer • **Voyager** • Discovery • New Frontiers • Mars Exploration Rover
Human spaceflight programs	Past	X-15 (suborbital) • Mercury • Gemini • Apollo • Apollo–Soyuz Test Project (with USSR) • Skylab • Shuttle–Mir (with Russia) • Space Shuttle program • Constellation program
	Current	International Space Station program • Commercial Orbital Transportation Services (COTS) • Commercial Crew Development (CCDev) • Orion
Individual featured **missions** (human and robotic)	Past	COBE • Apollo 11 • Mercury 3 • Mercury-Atlas 6 • Magellan • Pioneer 10/11 • Galileo • GALEX • GRAIL • WMAP • Space Shuttle • LADEE • MESSENGER • Aquarius
	Currently operating	MRO • Mars Odyssey • Dawn • New Horizons • Kepler • International Space Station • Hubble Space Telescope • Spitzer • RHESSI • SWIFT • THEMIS • Mars Exploration Rover • Curiosity rover (timeline) • Opportunity rover (observed) • Cassini • GOES 14 • Lunar Reconnaissance Orbiter • GOES 15 • Van Allen Probes • SDO • Juno • Mars Science Laboratory (timeline) • NuSTAR • Voyager 1/2 • WISE • MAVEN •

Active	Discovery • Explorer (Small Explorer) • Flagship • Mars Exploration • New Frontiers • **Voyager**
Completed	Apollo • Lunar Orbiter • Lunar Precursor • Mariner • Mars Scout • Mars Surveyor '98 • MESUR • Pioneer • Planetary Observer • Ranger • Surveyor • Viking
Cancelled	Constellation • Mariner Mark II • New Millennium • Grand Tour • Project Prometheus • Voyager (Mars)

Template:Flagship Program Template:Jupiter

V•T•E **Europa**



	Craters	Pwyll
	Lists	List of lineae on Europa • List of geological features on Europa • List of craters on Europa
Exploration	Past	Pioneer 10 • Pioneer 11 • Voyager 1 • Voyager 2 • Galileo • Cassini–Huygens • New Horizons
	Planned	Jupiter Icy Moon Explorer (launches 2022) • Europa Multiple-Flyby Mission (launches 2024)
	Cancelled/ Concepts	Jupiter Europa Orbiter • Europa Orbiter • Jupiter Icy Moons Orbiter • Jovian Europa Orbiter • Europa Lander (rerouted to Ganymede as Laplace-P)
	Proposed manned	Colonization of Europa
Other		Life • Europa in fiction

Template:Callisto Template:Ganymede Template:Io Template:Titan Template:Saturn

V • T • E **Uranus**

Geography		Atmosphere • Climate • Dark Spot • Magnetosphere • Rings
Moons		Ariel • Miranda • Oberon • Puck • Titania • Umbriel
		Gerard Kuiper • James L.

		d'Arrest • William Lassell • Urbain Le Verrier
Astronomy	General	Kuiper belt • Neptune-crossing minor planets
	Trojans	2001 QR_{322} • 2004 KV_{18} • 2004 UP_{10} • 2005 TN_{53} • 2005 TO_{74} • 2006 RJ_{103} • 2007 VL_{305} • 2008 LC_{18} • 2011 HM_{102}
Exploration	Past	Voyager 2 (1989 flyby)
	Proposed	ODINUS • Triton Hopper
	Cancelled	Argo • Mariner Mark II •

Book • Category Category • Portal

Categories

List of active duty United States four-star officers
Military Wiki


SOUNDS DODGY...
Fandom


UNIVERSAL CONQUEST